MARY KAY O'CONNOR PROCESS SAFETY CENTER
TEXAS A&M ENGINEERING EXPERIMENT STATION

18th Annual International Symposium
October 27-29, 2015 • College Station, Texas

Building on the Foundation of Process Safety by Incorporating Barrier Integrity Assurance

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Abstract

As operating companies continue to strive for improvement in the areas of process safety and integrity management, the need for an integrated approach becomes more evident. Many operators have become adept at conducting inspection, maintenance, and testing activities for equipment and piping, but the program and strategy for ensuring the integrity of controls and barriers can be improved. Barrier Integrity Assurance (BIA) focuses on ensuring process safety fundamentals are appropriately applied to safety critical elements, barriers, and activities to ensure asset integrity in an organization.

A comprehensive approach to BIA can provide a means of bringing together the activities already being undertaken, determine improvements that are needed, and provide assurance that assets are protected and Inspection, Testing, and Preventive Maintenance (ITPM) activities are planned, carried out, reported, and acted upon in an effective, efficient manner. It combines a process safety management framework with the identification and evaluation of operational hazards and integrity related threats to ultimately provide assurance that safety critical equipment and barriers in place are healthy. BIA provides a roadmap, or work process, that is applied to provide assurance throughout an asset's lifecycle from design and development through operation and eventually decommissioning.

Introduction

The oil and gas industry continues to become more complex every year; however, the hazards we face are the same, and they should be managed effectively on a daily basis. Even with all that is being done, organizational incidents continue to occur. Many such incidents have occurred because of a combination of inadequate technical integrity and process safety, and they have been the impetus for emerging regulatory changes and changes to recommended practices in the industry. One particular challenge has been to strengthen the work on barrier integrity assurance.

As a response to this challenge, BIA can be used to help strengthen technical integrity and overall process safety.

For the purpose of this paper, we can define Barrier Integrity Assurance as a process for assessing and ensuring the performance of barriers that are expected to prevent or minimize a major accident. This is not a new concept, but the extent to which the integrity of barriers is ensured can differ from one organization to another. Guidelines and standards stating the requirements for process safety and major accident risk management are described to varying degrees by regulators in different countries; however, the ways in which organizations comply with them varies.

The goal is to unify knowledge and resources associated with asset integrity, and raise the level and quality of assurance for both hardware and organizational barriers across the assets.

Industry Leaders

The level of maturity that has been seen from industry leaders in developing methods and processes for improving and ensuring both process safety and technical integrity varies greatly from limited involvement to evolved, cooperative efforts. Many companies are doing some type of barrier assessment, the most common of which is through bowties. In most cases, barriers are identified, and a value of effectiveness is placed upon them either using qualitative or semi quantitative means. This is very beneficial and is a significant step toward understanding how major accident risk is managed. The next step is to go a bit further to truly understand how those barriers are expected to function, how likely it is that they will function correctly when needed, and what the organization does to ensure they have the highest likelihood of success.

One observed industry leader in risk management has developed a program to manage hazards that could lead to process safety incidents and maintain the hardware safety critical barriers that will help lower the likelihood of an incident or minimize the consequence if an event does occur; however, the organizational barriers, such as procedures and processes, are not well managed. Another organization has developed their program largely by utilizing a similar approach to the first but also taking advantage of outside assistance for carrying out the evaluations against Performance Standards.

Although companies are improving and showing significant progress, there is still room for improvement. Bringing together a framework, such as the one outlined in this paper is one way to provide solutions that will help organizations begin to make strides toward effective management of technical integrity and process safety and also push the industry leaders toward a level of excellence.

Barrier Integrity Assurance Programs

Regardless of the approach used, Barrier Integrity Assurance cannot be performed as a stand-alone activity. It must incorporate many other activities related to operations, maintenance and process safety management. For this reason, it is essential to have a clear structure and

understanding of what forms the basis for a good system that will help an organization manage barriers in daily operation to maintain process safety and, in turn, prevent major accidents.

BIA is only one piece of the puzzle when it comes to managing major accident risk. It should be combined with other process safety and risk management activities for a truly comprehensive approach.

BIA Objective

The main objective of a BIA framework is to provide an increased understanding of the relationship and interaction of barrier integrity and process safety, with strong emphasis on designing and maintaining effective barriers. It is possible to capitalize on already existing programs and processes related to process safety with the goal of packaging all of these in a consistent, coherent way for effective long-term solutions.

It should be recognized that different companies have different needs depending on the company size, budget, resources, and maturity level in the area of process safety and integrity. Hence, what is best for one company may not be the best for another. Consequently, the framework should be scaled according to the needs of an individual organization so that challenges can be resolved appropriately. Companies should review good practices and consider what is in place, what the possible improvement areas are, and ways to go about refining their practices and activities in the way that is most helpful to them.

The Pieces of the Puzzle

Ideally, Barrier Integrity Assurance would be implemented in combination with other pieces of a management system, complete with training and competence requirements to ensure proficiency and complete understanding; however, it is unlikely that all organizations will have the same types of systems and the same needs. It may be necessary to start with one piece and grow the system. For this reason, BIA is only one piece of a larger puzzle.

As shown in Figure 2, the Verification & Performance step and the Assurance step are those that encompass the majority of the BIA pieces that can be further developed to ensure the integrity of process safety related barriers. The ways in which the pieces come out of the hopper depend upon the organization and its inherent, or desired, culture.

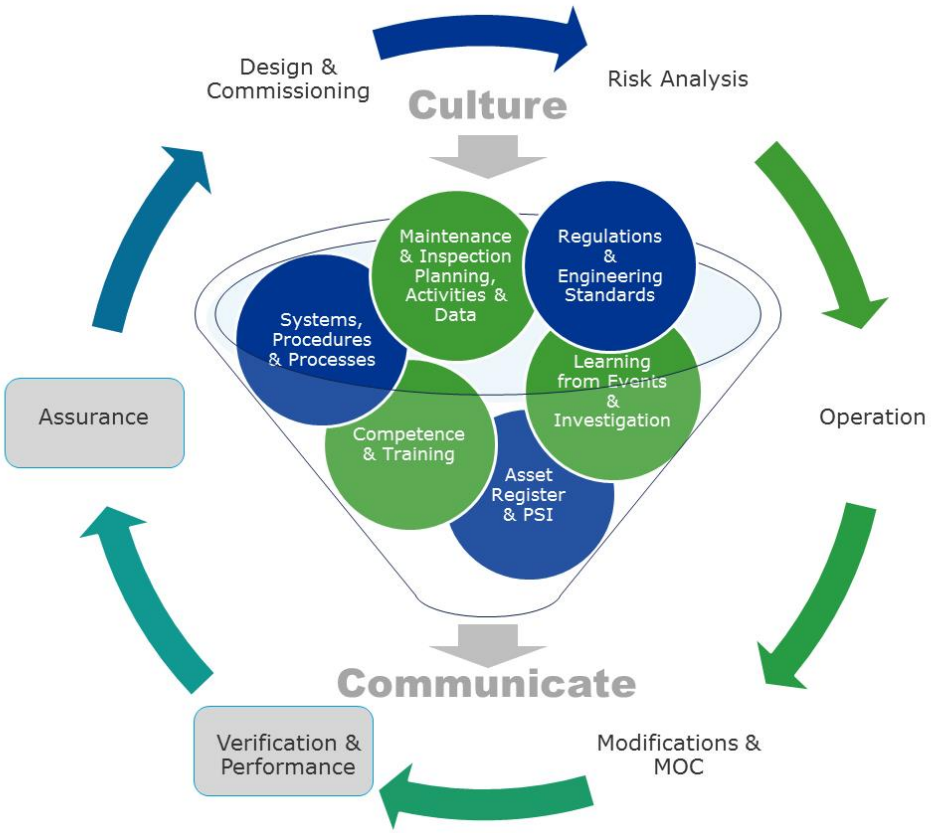


Figure 1: Barrier Integrity Puzzle

The BIA framework should include a process, for implementing solutions in operations and understanding how safety critical equipment (SCE), safety critical organizational barriers (i.e., procedures and processes linked to human interaction), and asset performance can be maintained. The overall framework or system document should provide a description of methods, tools and activities for systematic implementation and performance management of safety critical barriers.

It is likely that companies have conducted PHAs, identified barriers and SCE, and developed risk-based inspection plans, but there are other questions that should be answered as part of a successful BIA framework:

- What has been done to ensure the integrity of the critical barriers when a demand is placed upon them?
- How are the inspection and testing data used?
- How do companies know the right activities are being done to ensure the barriers will work?
- What drives the activities – regulations, company requirements, industry peers?

<u>Management Systems – How it all Works Together</u>

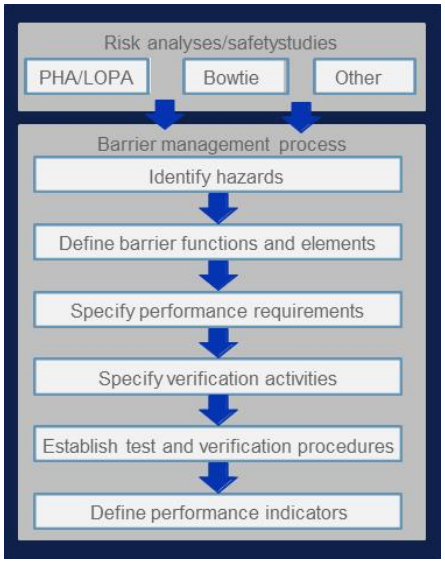
Management Systems are the foundation for all other processes. To ensure the foundation is solid, a management system framework should be in place with documented supporting work processes, roles and responsibilities, change management process, and the organizational

structure needed to support the management system. This system may be an existing Process Safety Management (PSM) system, Risk Management System, or another system that logically includes the elements needed to support BIA. Aligning the system to a recognized industry standard (e.g., ISO 55000 or API 1173) or to a company standard, will help to ensure the necessary pieces are in place from the start.

The system structure should include links from one element to another, and it should explain how the BIA framework should be implemented and used. Training and competence building should be effectively utilized to ensure individuals with the appropriate level of expertise are evaluating barrier performance against the performance standards.

Whether a company has a mature management system or is beginning to build a system, it is never too late to get the system right. It is recognized that some oil and gas sectors, such as offshore and refining, are likely to have a system in place for process safety or risk management. Other sectors may not have a functioning management system; however, they may have pieces of a system as part of their integrity management programs.

Risk Identification and Performance Standards



As is common practice with PSM, the information gained through risk analyses and process hazard analyses (PHAs) is extremely valuable toward understanding what the major accident risks are and what safety critical barriers – equipment, procedures, processes, and human elements – are in place to prevent them or mitigate their consequences.

To take this further, it is important to develop performance standards against which the barriers can be measured. These standards combine the pieces of a traditional process safety and safety cases to provide assurance that safety critical barriers and functions will perform as intended when required. For this to be successful it is a pre-requisite that the organization has determined what should be considered as safety critical barriers and how they must perform during a given event to stop the chain of events or minimize the magnitude of the consequences.

Utilizing the results of the studies, major hazards are identified, and the safety critical barriers and functions that are in place to protect against the manifestation of those hazards are defined. It is important that the organizations can ensure the following for each barrier:

1. Function – the way the barrier was designed to work and the action it should perform
2. Reliability – the barrier's ability to perform as intended
3. Availability – the barrier's availability to function as intended when it is needed
4. Survivability – of the barrier after an event (particularly for barriers expected to mitigate the consequences of an event)

Through the use of performance standards, the technical and operational (human) elements of these barriers can be evaluated, and assurance that they will perform as intended on demand can be made. Utilizing the results of PHAs and LOPA studies can make the performance standards uniquely powerful tools, which will provide the following:

- Description of the intended function of the barrier
- Supporting procedures and processes
- A breakdown of tasks associated with ensuring proper barrier functions
- Performance requirements

As previously mentioned, it is important to have the appropriate expertise involved in conducting these evaluations; therefore, the required competence should be outlined in the management system.

Links to Maintenance and Inspection Programs

Effective Inspection, Testing, and Preventive Maintenance (ITPM) are essential for ensuring the technical integrity of safety critical barriers. BIA requires an ITPM or Mechanical Integrity program where the written program and plans follow the performance standard requirements. ITPM activities should then be planned and carried out in a manner that will meet the standards. To achieve this goal, it is also necessary to ensure the competence of maintenance, inspection and testing personnel. These individuals must have a firm understanding of the reasons why the activities are being done and what hazards can manifest if the equipment is not in proper working order.

It is recognized that companies often have difficulty utilizing the full functionality of computerized maintenance management systems (CMMS); therefore, improving the functionality by defining the inputs that should be mandatory for entry into the CMMS is a valuable activity early in the process. If the inputs are consistently entered, trending can be performed, and the organization can determine if there are systemic problems to be corrected. Finally, key performance indicators (KPIs) can be pulled from the data in the CMMS.

The first step should be to verify and reconcile the asset register with the physical assets. This provides the groundwork for the remaining elements, because the only way to ensure all assets are being protected adequately is to have a validated list of equipment. Once this has been achieved, it is possible to map the safety critical barriers to specific equipment listed in the register.

Verification of Barrier Design, Use and Condition

Mechanical Integrity and Operational programs and procedures should be verified in the field to determine the following for all barriers (both SCE and safety critical procedures/processes):

1. Are the barriers designed appropriately?
2. Are the barriers being used in the manner for which they were designed?
3. Does the physical condition of the barrier fulfil the requirements of the Performance Standards? To what extent?
4. To what extent do the barriers reduce risk?

To conduct a field verification, it is important to conduct interviews with field personnel, review documents and records (i.e., inspection and test records, historical operating data, etc.), and verify the processes and procedures used to conduct such activities. This verification requires a team with specialized knowledge of the types of tests, inspections, maintenance activities, and unique operating philosophy, and if this expertise does not exist, the required competence may need to be improved. This, again, points to why it is critical for the management system to have clearly stated requirements for competence in evaluating barriers against the performance standards.

It is essential to have a clear understanding of how humans must interact with safety critical equipment and operational (procedural) barriers to ensure their functionality. For example, if a critical alarm is being relied upon as a barrier against overpressure, it is necessary to know how long the operator has to respond to the alarm and whether or not that amount of time is adequate to stop the overpressure before a rupture occurs.

Design Assurance and Management of Change

Any changes to existing barriers should also be evaluated using hazard identification and risk assessment, and they should be evaluated against the appropriate performance standard(s) prior to start-up. It is critical to know if a modification can affect the function, reliability, availability, or survivability of barriers. For example, a new pump skid and associated piping are being installed in a position that will interfere with the fire eye on the fire detection and suppression system.

By verifying new and modified assets prior to their installation and commissioning, it is possible to verify the design and know how it can possibly affect existing barriers. An assessment team can review drawings and project documentation to ensure existing barriers will maintain their integrity and ensure the new design is also sound.

Continuous Improvement

A process aimed at providing continuous improvement of the BIA process should also be in place. This should include defined status metrics for barriers so that the metrics can be tracked and evaluated to determine the effectiveness of the system and its elements. The metrics should be tied directly to the performance standards and the management system, as defined earlier, and they should drive continuous improvement.

Both leading and lagging metrics and KPIs should be identified and tracked using defined work processes to support the management system and its assurance element. The first step is to determine the appropriate level of detail needed to fully understand the effectiveness of the system.

As previously mentioned, when all is said and done, the way the pieces fall out of the hopper may vary depending on the organization. Figure 3 shows just one such way; however, the possibilities are limitless. The keys to success include using a management system approach to

govern the roles and responsibilities, competency and training requirements, and procedures and processes required to support the BIA framework. In addition, the company's culture will drive the implementation style and effectiveness, so this should be considered when determining the framework structure.

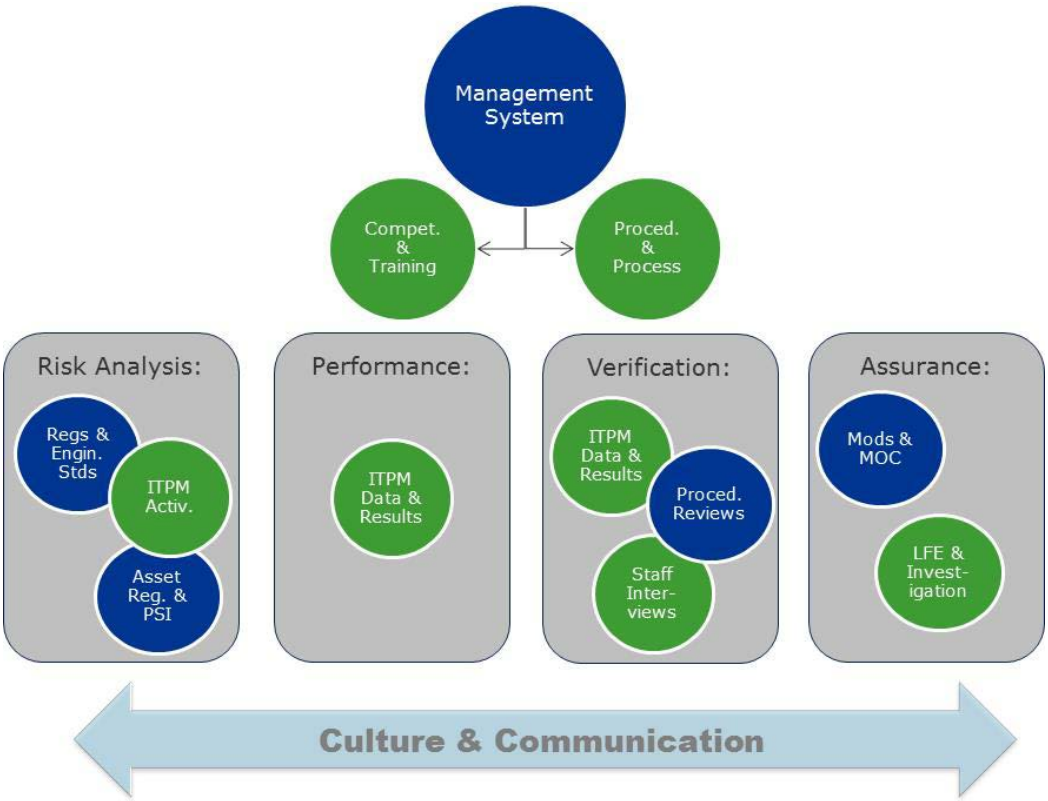


Figure 2: Possible Structure of a BIA Framework

Conclusions

A number of benefits can be recognized through effective Barrier Integrity Assurance:

1. Standardized approach for ensuring barrier integrity
2. Simplified, targeted data collection through improved inputs and use of CMMS
3. Improved competence and understanding of risk and barrier management
4. Use of the performance evaluations as a basis for management risk-based decision making
5. Improved HSE performance
6. Increased productivity

It is recognized that many companies have well-established routines for activities related to integrity management, such as maintenance, training, and processes for safe operation. Barrier Integrity Assurance taps into such practices by providing a more structured, integrated and systematic approach to managing major accident risk. For this reason, the suggestion is to encourage companies not to introduce new and additional systems, but instead adapt and utilize existing practices to accompany principles for technical integrity assurance and process safety. This will help to ensure the process is not a time consuming "add-on" subject to frustration among already busy employees. Instead it can become an integrated part of managing the asset.

References

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